

WHAT IS CLAIMED IS:

- 1 1. A method of forming an integrated circuit package having a sensor with
2 imaging capability comprising:
3 connecting components to a single-piece substrate, including
4 fixing an integrated circuit die to a first area of said single-piece substrate
5 and fixing a light source to a second area of said single-piece substrate, said
6 integrated circuit die having said sensor; and
7 enclosing said components to define said integrated circuit
8 package having exposed input/output connections and having a window
9 optically aligned with said sensor;
10 wherein said first and second areas of said single-piece
11 substrate are at an angle to each other within said integrated circuit package,
12 such that an axis of light from said light source is non-parallel to an imaging
13 axis of said sensor and such that said light source illuminates a field of view of
14 said sensor.
- 1 2. The method of claim 1 wherein said single-piece substrate is a lead frame,
2 said fixing of said integrated circuit die including using die attach techniques.
- 1 3. The method of claim 2 wherein connecting said components includes
2 attaching said integrated circuit die and said light source to said lead frame
3 while said lead frame is substantially flat, said enclosing including bending
4 said lead frame to establish said angle of said first area to said second area.
- 1 4. The method of claim 3 further comprising forming an electrically insulative
2 material on opposite sides of said lead frame prior to connecting said com-
3 ponents, thereby defining a package form, said package form being patterned
4 to include a locking mechanism, said bending of said lead frame including
5 utilizing said locking mechanism to fix said lead frame in a position to
6 establish said angle.

1 5. The method of claim 4 wherein defining said package form includes
2 fabricating separate first and second portions on said lead frame, said first
3 and second portions having cooperative structural features which define said
4 locking mechanism.

1 6. The method of claim 1 further comprising patterning electrically insulative
2 material onto opposite sides of said one-piece substrate to define a package
3 form in which said first and second areas of said one-piece substrate are fixed
4 at said angle.

1 7. The method of claim 6 wherein said one-piece substrate is a lead frame,
2 said patterning including enabling input/output connections to remain exposed
3 at an exterior of said package form.

1 8. The method of claim 6 wherein connecting said components includes
2 using die attach techniques to connect said integrated circuit die and light
3 source in separate passes of said lead frame through a fabrication line.

1 9. The method of claim 1 wherein connecting said components includes
2 providing said integrated circuit die to include a matrix of pixel elements and
3 to include digital signal processing circuitry, said angle being selected to
4 establish a light-source-to-sensor relationship in which light from said light
5 source illuminates a surface being imaged by said matrix of pixel elements,
6 said matrix of pixel elements being said sensor.

1 10. The method of claim 9 wherein enclosing said components includes
2 attaching a lens system for directing said light from said light source and
3 for collecting light reflected from said surface toward said matrix of pixel
4 elements, thereby providing a module for electrical and mechanical
5 connection within an electronic device.

1 11. The method of claim 10 wherein connecting said components includes
2 providing said integrated circuit die such that said digital signal processing
3 circuitry is dedicated to generating navigation information specific to move-
4 ment of said sensor relative to said surface being illuminated by said light
5 source.

1 12. An integrated circuit package comprising:
2 a package body having an interior defined by at least one
3 interior region;
4 a single-piece substrate at least partially within said interior of
5 said package body, said single-piece substrate having a surface with first and
6 second areas along planes which are at a non-aligned angle to each other;
7 an integrated circuit die attached to said first area of said
8 single-piece substrate, said integrated circuit die including a sensor aligned
9 with an optical window to enable imaging therethrough; and
10 a light source on said second area of said single-piece substrate
11 in a position to direct illumination from said interior of said package body to a
12 field of view of said sensor.

1 13. The integrated circuit package of claim 12 wherein said integrated circuit
2 die includes circuitry dedicated to determining navigation information from
3 image data acquired by said sensor, said navigation information being specific
4 to movement of said sensor relative to an external surface being imaged.

1 14. The integrated circuit package of claim 12 wherein said angle of said first
2 area relative to said second area is in the range of thirty degrees to one
3 hundred and seventy-five degrees, said integrated circuit die and said light
4 source having optical axes that are at an angle within said range.

1 15. The integrated circuit package of claim 12 wherein said package body
2 includes a lid having first and second lenses, said first lens being aligned with
3 said light source to direct light toward a surface of interest, said second lens
4 being aligned with said sensor to collect light reflected from said surface of
5 interest.

1 16. The integrated circuit package of claim 15 wherein said sensor is a
2 matrix of pixel elements and wherein said integrated circuit die includes
3 navigation-specific circuitry connected to said matrix.

1 17. A method of forming an integrated circuit package comprising:
2 providing a generally flat lead frame having spaced apart
3 first and second areas for receiving components and having a plurality of
4 input/output conductors;
5 forming a first package portion about said first area of said
6 lead frame;
7 forming a second package portion about said second area of
8 said lead frame;
9 fixing a sensor die to said first area, including electrically
10 connecting said sensor die to at least some of said input/output conductors;
11 fixing a light source to said second area, including electrically
12 connecting said light source to at least one of said sensor die and said
13 input/output conductors; and
14 bending said lead frame in a region between said first and
15 second areas to establish a condition in which light from said light source
16 illuminates a field of view of said sensor die.

1 18. The method of claim 17 further comprising securing said lead frame in
2 said condition using physical features of said first and second package
3 portions, wherein said first and second package portions are formed using
4 molding techniques.

1 19. The method of claim 17 wherein fixing said sensor die includes using die
2 attach and wire bonding techniques for a device having a matrix of pixel
3 elements and circuitry dedicated to determining navigation information.

1 20. The method of claim 17 further comprising attaching a lid to said first and
2 second package portions after said bending, said lid including a lens system
3 for directing said light from said light source and collecting light for said sensor
4 die, wherein attachment of said lid forms a module for connection within an
5 electronic device.

1 21. A method of forming an integrated circuit package comprising:
2 fabricating a lead frame having a plurality of input/output
3 conductors, said lead frame having spaced apart first and second areas for
4 receiving components;
5 forming a package body of electrically insulative material on
6 said lead frame such that said first and second areas are at a selected angle
7 with respect to each other;
8 fixing a sensor die to said first area, including electrically
9 connecting said sensor die to at least some of said input/output conductors;
10 and
11 fixing a light source to said second area, including connecting
12 said light source to at least one of said sensor die and said input/output
13 conductors;
14 wherein said selected angle is such that a condition is
15 established in which light from said light source illuminates a field of view of
16 said sensor die.

1 22. The method of claim 21 wherein fixing said sensor die includes using die
2 attach and wire bonding techniques for a device having a matrix of pixel
3 elements and circuitry dedicated to determining navigation information.

1 23. The method of claim 21 further comprising attaching a lid to said package
2 body, said lid including a lens system for directing said light from said light
3 source and collecting light for said sensor die, wherein attachment of said lid
4 forms a module for connection within an electronic device.

1 24. The method of claim 21 wherein fixing said sensor die includes using die
2 attach and wire bond techniques for a die having a matrix of pixel elements
3 and circuitry dedicated to determining navigation information on the basis of
4 image information from said matrix.